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Enqvist et al.

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[54] **CONCRETE EXTRUSION MACHINE**

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[22] Filed: **May 16, 1991**

[51] **Int. Cl.**[5] **B28B 1/00**

[52] **U.S. Cl.** **425/63;** 264/70; 425/262; 425/426; 425/427

[58] **Field of Search** 264/70, 209.1, 209.2, 264/211.23; 425/62, 63, 64, 65, 262, 380, 426, 427, 432, 456

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,159,897	12/1964	Ellis et al.	425/64
3,284,867	11/1966	Booth	425/432
3,877,860	4/1975	Putti	425/64
4,022,556	5/1977	Goetjen	425/64
4,046,848	9/1977	Putti	425/64
4,292,014	9/1981	Lupke et al.	425/72 R
4,330,242	5/1982	Putti	425/64
4,568,503	2/1986	Laine et al.	425/426
4,755,338	7/1988	Harala	425/64
4,786,242	11/1988	Barsk	425/63
4,842,788	6/1989	Johnson	264/68
5,023,030	6/1991	Rantanen	425/427

FOREIGN PATENT DOCUMENTS

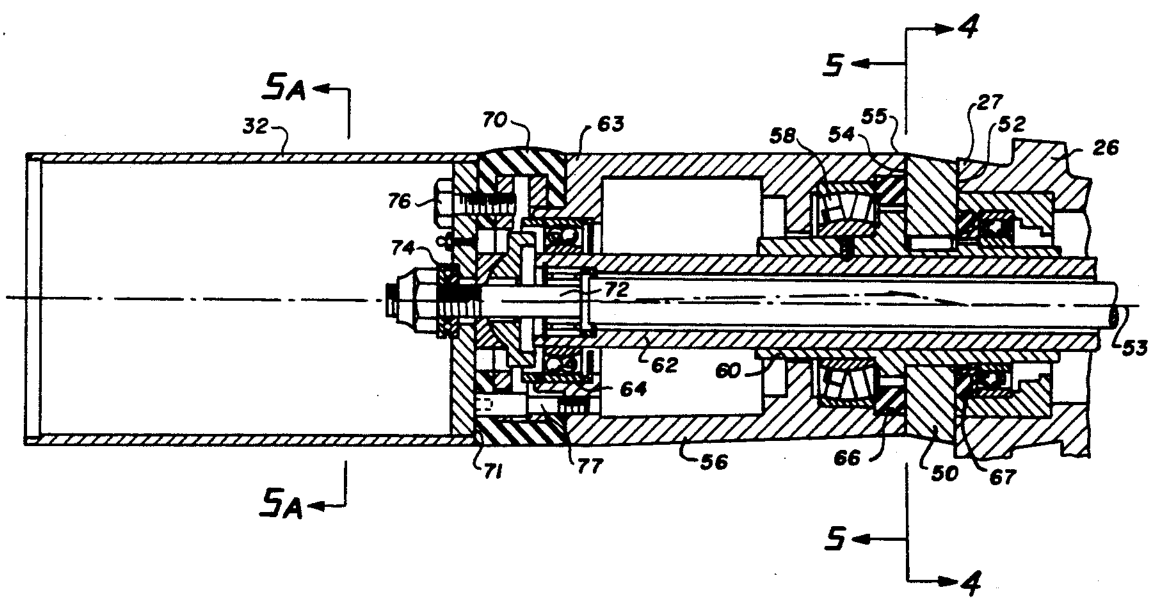
1193834	9/1985	Canada .
1205985	6/1986	Canada .
272860	8/1970	U.S.S.R. .

Primary Examiner—Jay H. Woo
Assistant Examiner—Scott Bushey
Attorney, Agent, or Firm—Townsend and Townsend

[57] **ABSTRACT**

An extrusion machine for making hollow elongated articles of concrete has an eccentric compaction disc that reciprocates and rotates to compact and release air from zero slump concrete. The machine avoids having to have a high frequency converter which is both expensive and noisy. At least one extruder screw is provided in the machine to feed concrete and form the elongated article. The screw has a die former at the outlet end to form a cavity in the elongated article. An eccentric compaction disc is positioned between the outlet end of the extruder screw and an input end of the die former, the input end of the die former is eccentric and coplanar with an eccentric disc face mounted for movement in a circular orbital path about the extruder screw axis. The output end of the die former is concentric with the extruder screw axis.

14 Claims, 7 Drawing Sheets



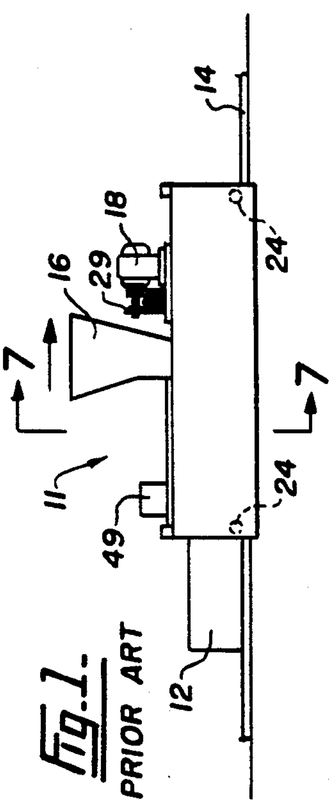


Fig.1.
PRIOR ART

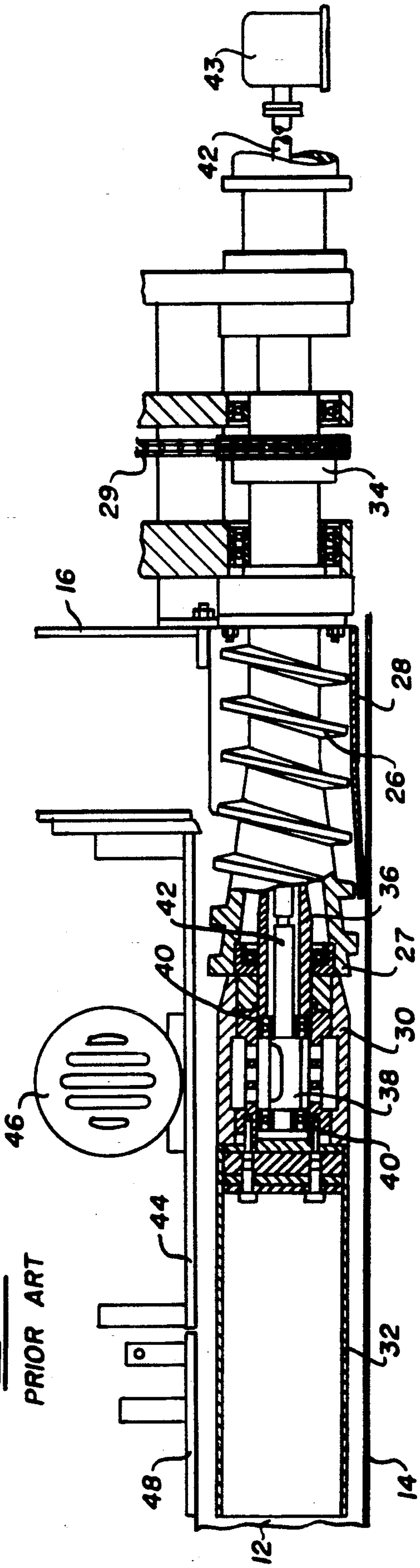


Fig.2.
PRIOR ART

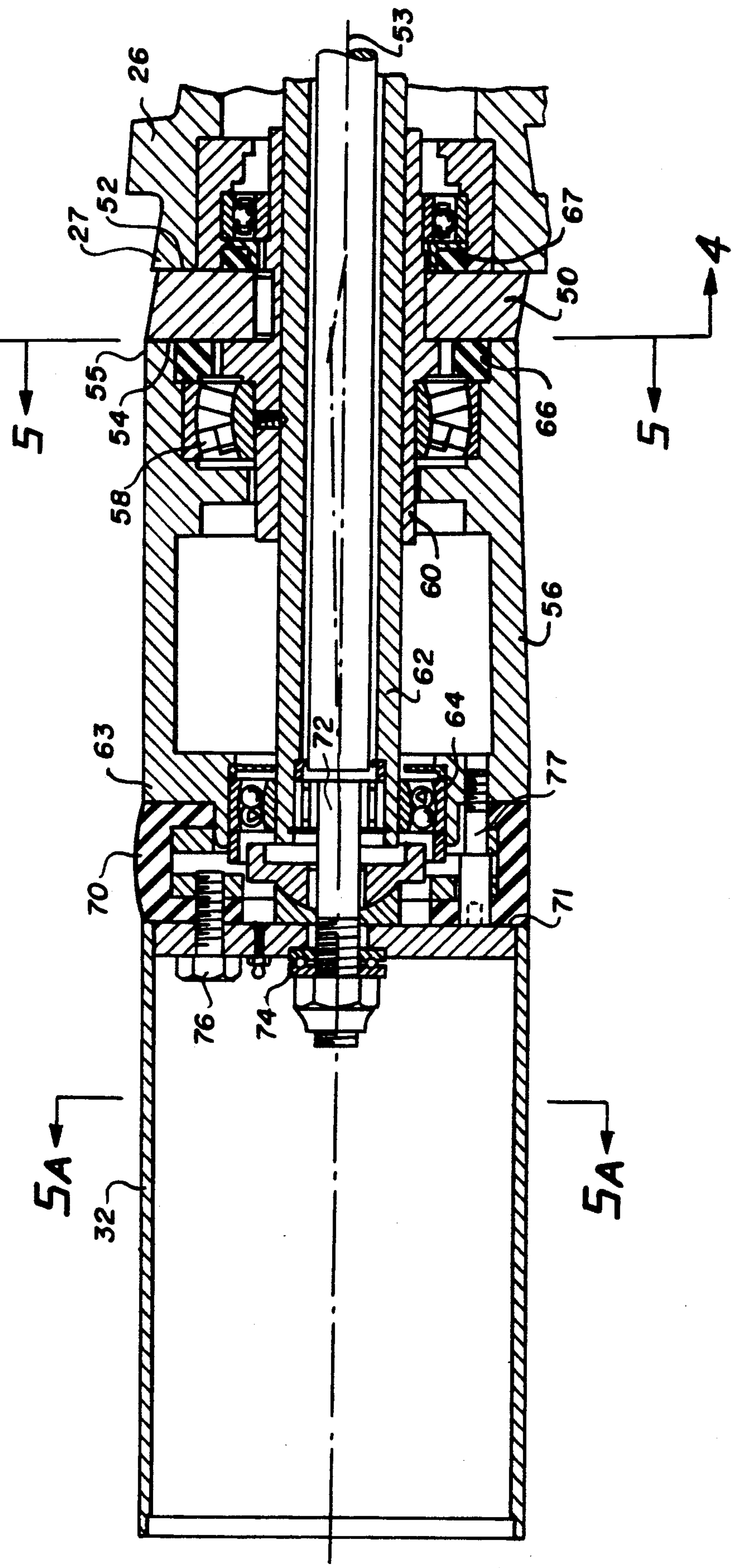

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Fig. 3.

Fig. 3A.

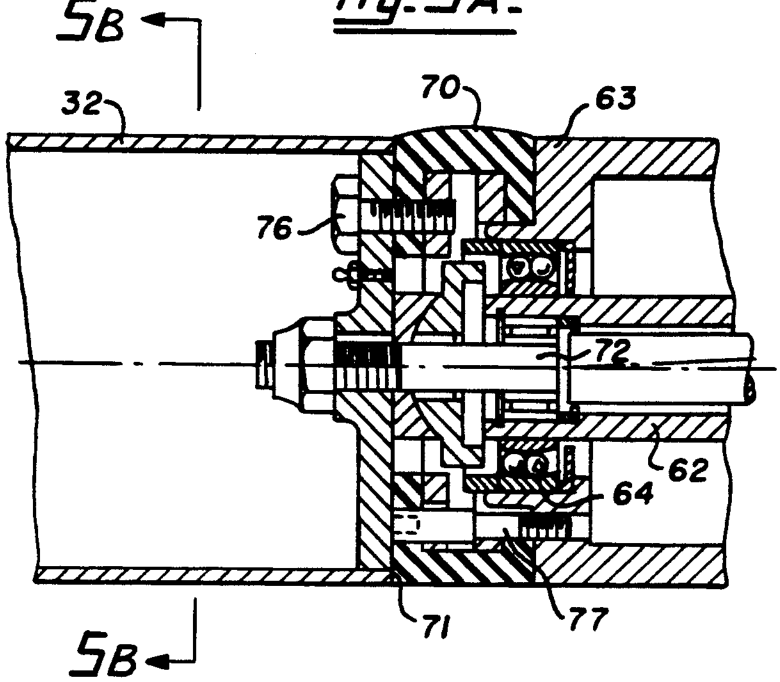


Fig. 5A.

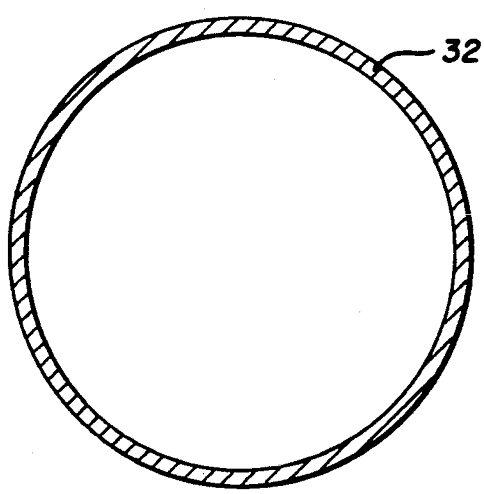
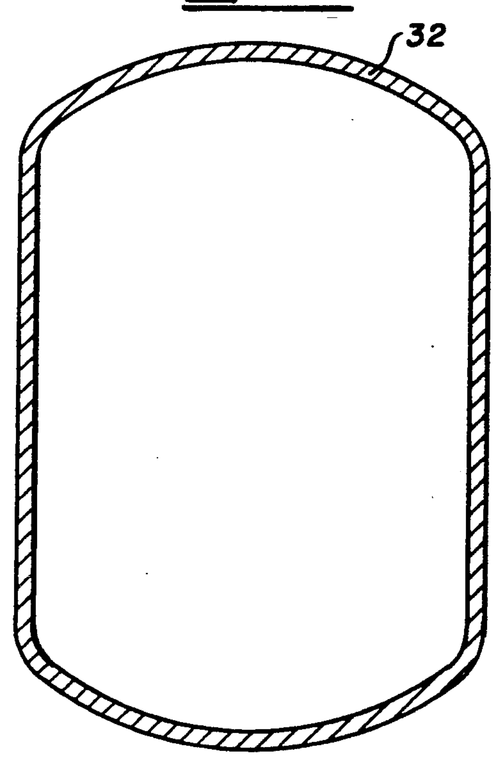


Fig. 5B.



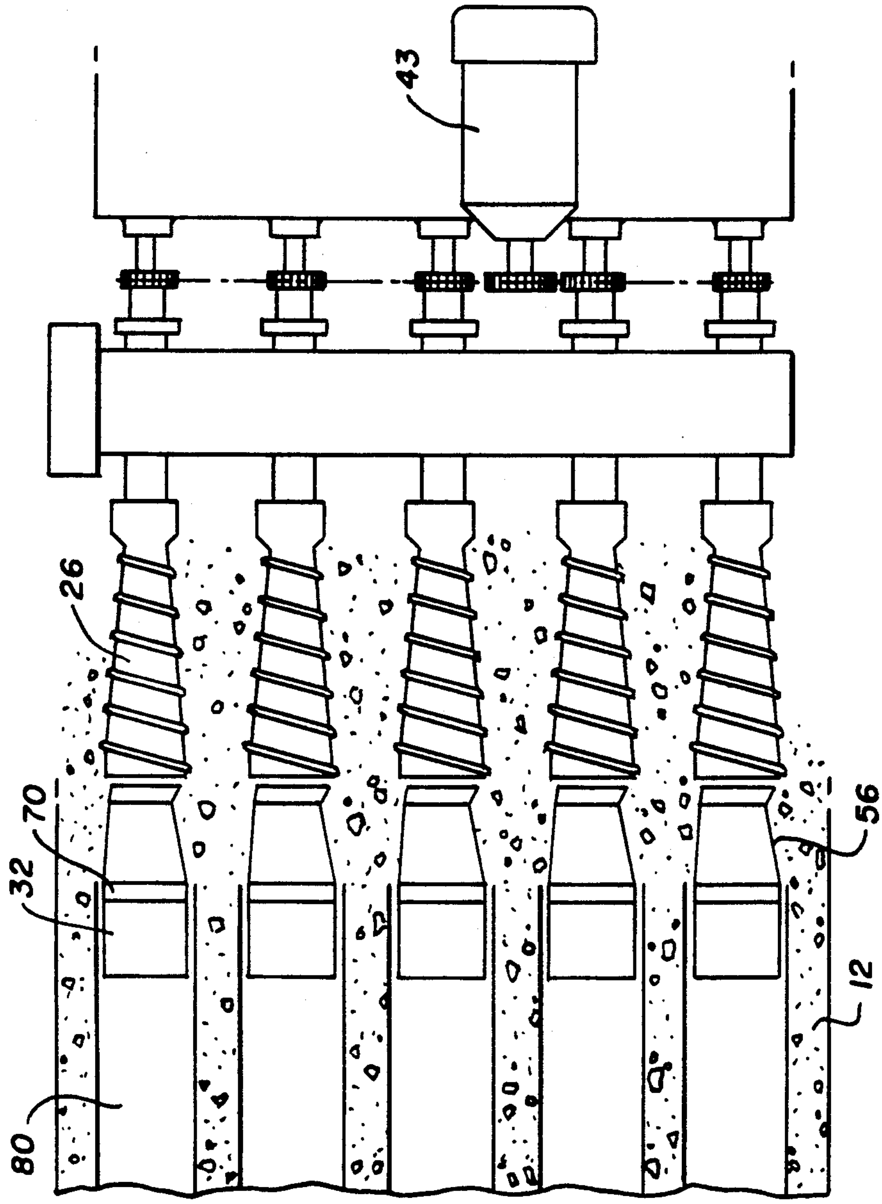


Fig. 6A.

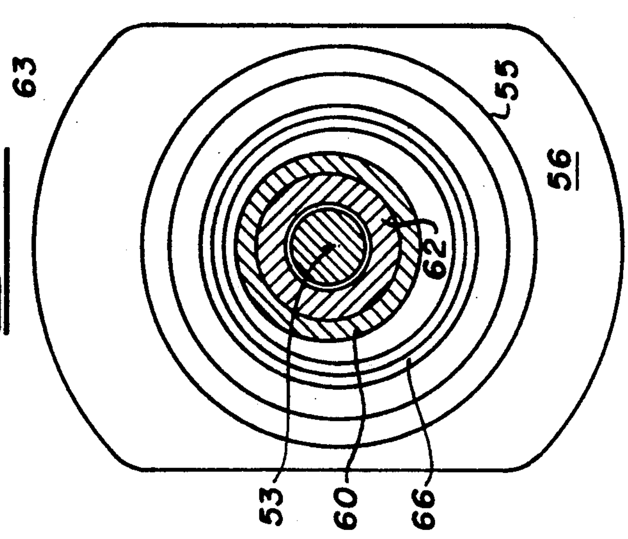


Fig. 5B.

Fig. 4.

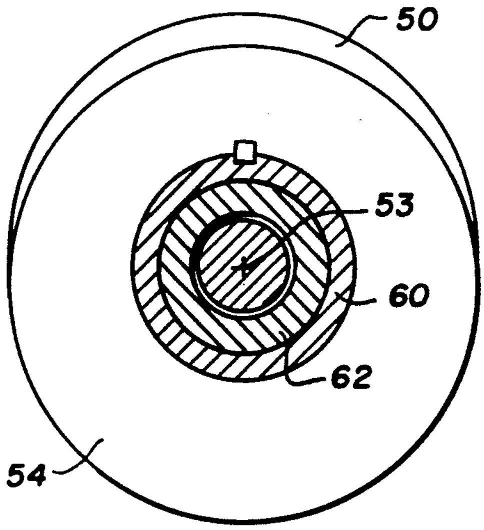


Fig. 5.

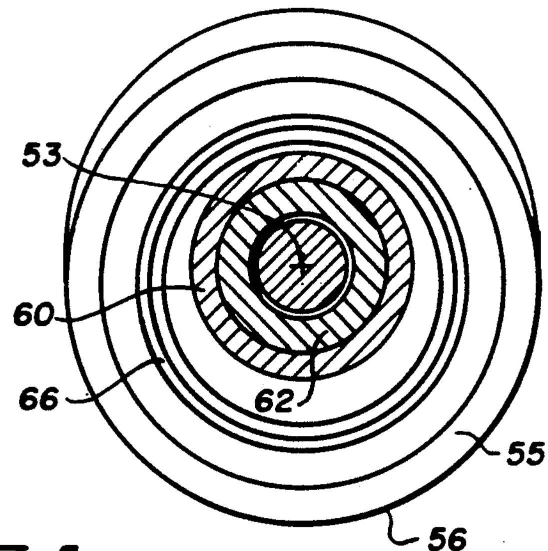


Fig. 6.

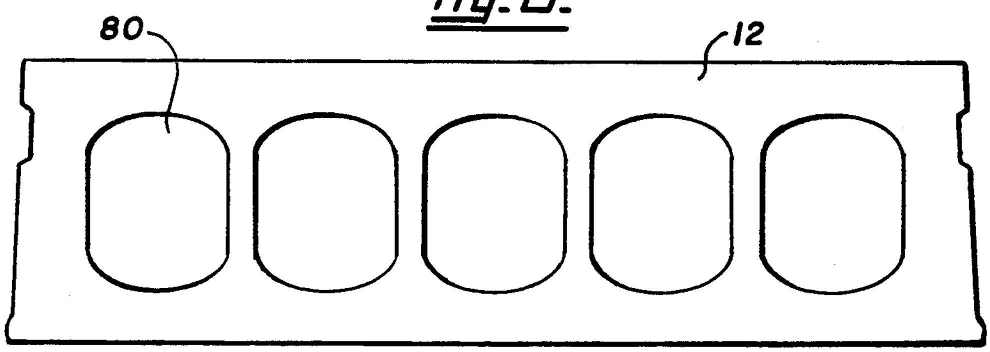
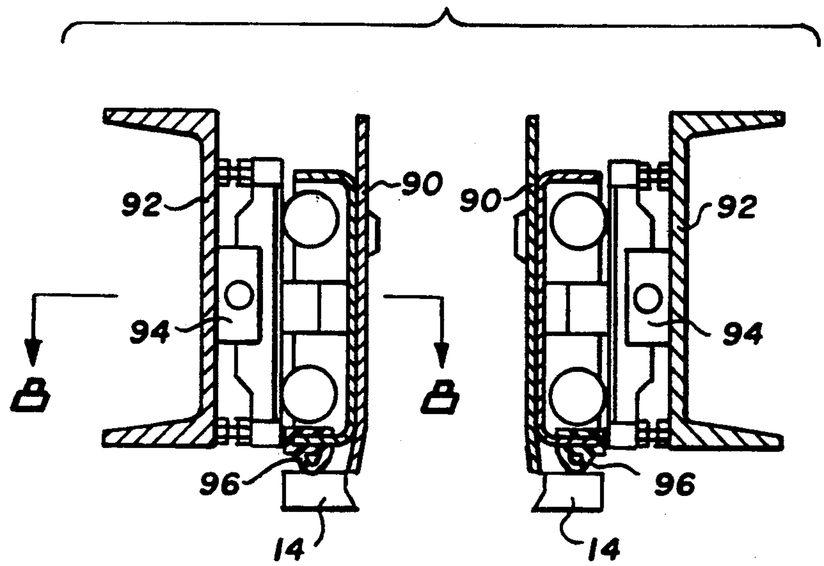


Fig. 7.



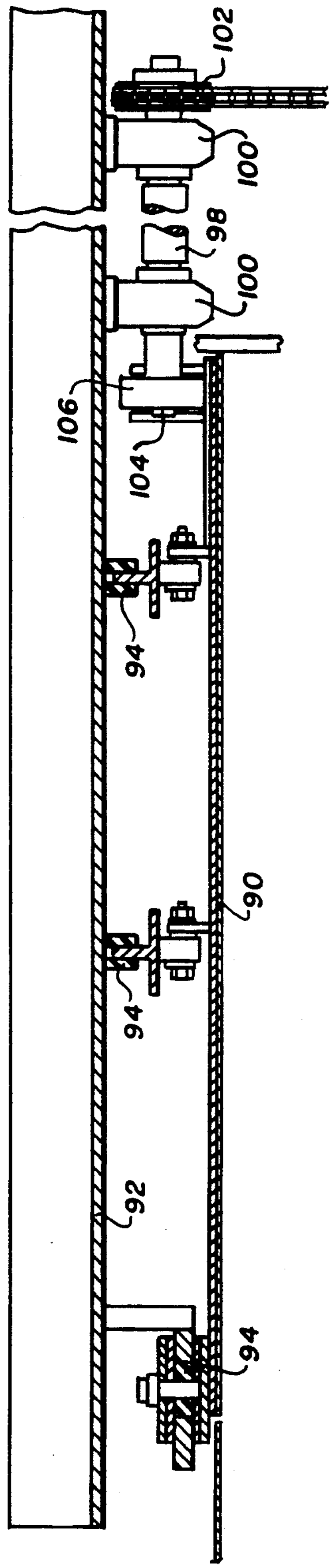


Fig. 8.

Fig. 9.

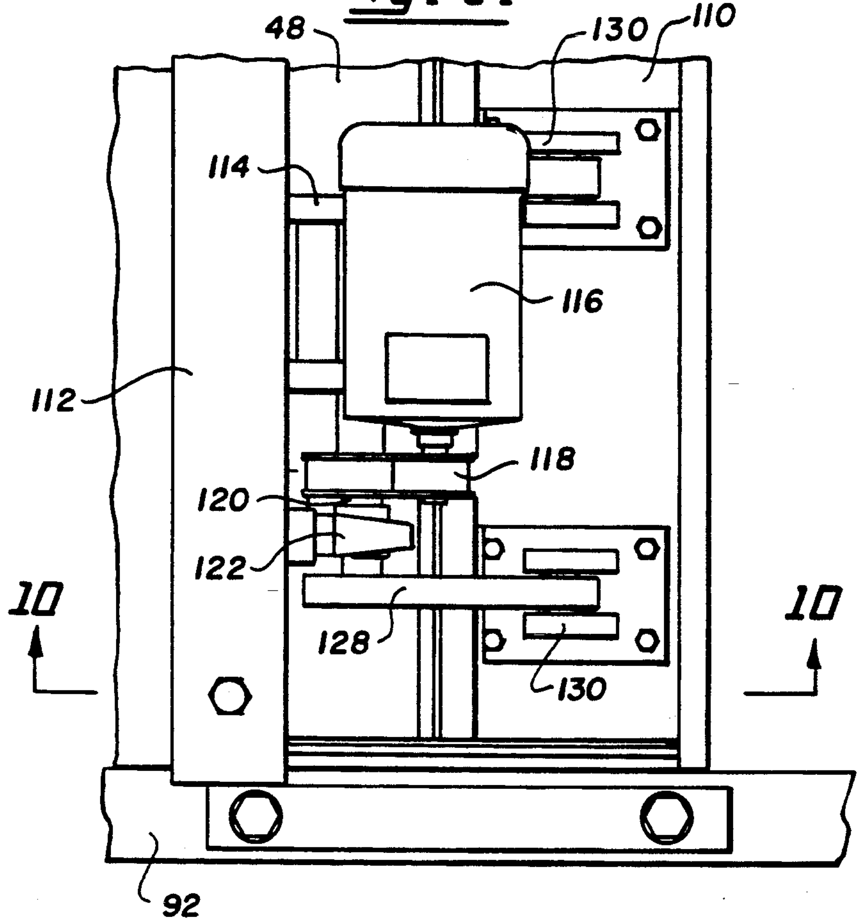

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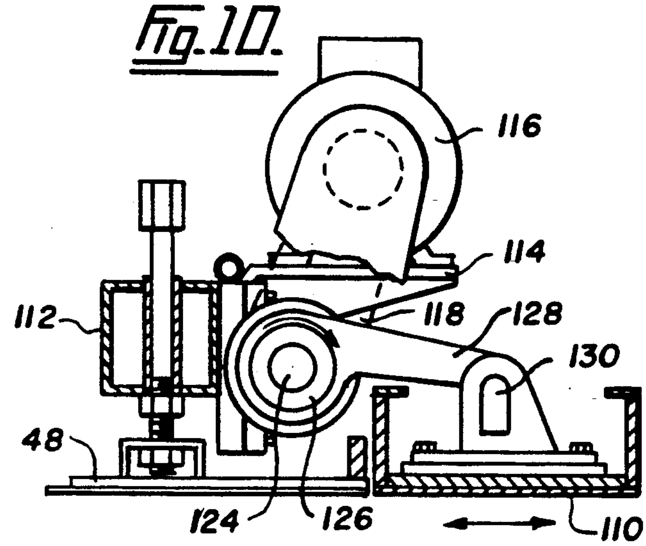
Fig. 10.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CONCRETE EXTRUSION MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to an extrusion machine for making hollow elongated articles of concrete and more specifically to a concrete extruder apparatus that provides improved compacting of the concrete without undue noise.

The extruding of concrete by means of one or more extruder screws into an elongated article, sometimes referred to as a slab or plank, which has hollow cavities therein to provide the minimum amount of concrete to provide the required strength, is known. One example of such a forming machine is disclosed in U.S. Pat. No. 4,548,565. In this machine, concrete is forced through extruder screws onto a deck. The machine has wheels that ride on tracks on each side of the deck. As the concrete passes from the extruder screws, the machine moves along the tracks, the movement caused by the extruding concrete. A non-rotatable forming element or die former is provided to form the hollow cavities immediately following the downstream end of the extruder screws. Thus the concrete slab is formed and slowly hardens on the deck as the machine moves along the tracks. Side plates and a top plate are provided to control the external dimensions of the slab and the apparatus moves slowly so that the concrete does not collapse. In this way, concrete slabs of almost any length can be produced. These slabs are later cut by means of a diamond saw into required lengths.

After extrusion and before the concrete hardens, it is necessary to compact the concrete and remove any air trapped therein. This is generally achieved by vibration. The vibration helps to remove air in the wet concrete which rises to the top surface of the slab. It is known to provide a vibrator on the top plate of the forming machine. This top plate controls the depth of the slab after it has been extruded. A vibrator is also provided in or adjacent the die former to compact the concrete and release air from the hollows and voids in the concrete. In most of the existing concrete extrusion machines it has been found that high frequency vibration is required. In order to achieve this a frequency converter is positioned on the machine to provide high frequency for motors to rotate at high speeds to drive vibrators on the top plate and in the die former. In most cases the motors have rotation speeds in the order of 12,000 rpm. Whereas this arrangement works well, the converters produce an excessive noise causing an unpleasant environment for operators and others. Attempts to provide lower vibration frequencies on the top plate of the extrusion machine have been partially successful, but lower vibration frequencies on the vibrator in the die former has not provided satisfactory compacting of the concrete. The die former used in existing machines is a rigid steel unit, high frequencies are transmitted through the die former to the uncured, zero slump concrete, but low frequency does not provide sufficient vibration to fully compact the formed slab.

A vibration system presently available for die formers includes an eccentric weight on a shaft that rotates inside the die former at speeds as high as 12,000 rpm. The die former is made from steel and is rigid, thus high frequency vibrations are required in order to transmit the vibration through the die former to the concrete to provide compaction and air release.

SUMMARY OF THE INVENTION

It is an aim of the present invention to provide a concrete extrusion machine that compacts and releases air from zero slump concrete as the machine moves along on tracks with significantly reduced noise emissions. This will be achieved by eliminating the noisy and expensive frequency converter and high speed motors previously required. It is a further aim to provide a die former which is more flexible and has an eccentric entry end which follows a circular orbital path. Thus, a vibration or movement is provided by the die former itself rather than providing a separate vibrator within the die former.

The present invention provides in an extruder apparatus for making an elongated article of concrete, including at least one extruder screw and feed means to feed concrete to the extruder screw to form the elongated article and move the apparatus along a track, the extruder screw having a die former at an outlet end, adapted to form a cavity in the elongated article, and a finishing tube at an output end of the die former to provide smooth walls in the cavity, the improvement of means for compacting the elongated article while being formed, comprising: an eccentric compaction disc between the outlet end of the extruder screw and an input end of the die former, the disc having a concentric disc face adjacent the outlet end of the extruder screw concentric with an extruder screw axis, and an eccentric disc face eccentric with the extruder screw axis, the input end of the die former being eccentric and coplanar with the eccentric disc face, mounted for movement in a circular orbital path about the extruder screw axis, the output end of the die former being concentric with the extruder screw axis, and means to concurrently rotate the disc and cause the input end of the die former to move in the circular orbital path.

BRIEF DESCRIPTION OF DRAWINGS

In drawings which illustrate embodiments of the invention:

FIG. 1 is a general view of a concrete extrusion machine known in the prior art.

FIG. 2 is a longitudinal sectional view through a concrete extrusion machine of the type shown in FIG. 1 having an eccentric weight rotatable in the die former to provide a vibration. This represents the prior art known today.

FIG. 3 is a longitudinal sectional view showing a detail of the die former, finishing tube, compaction disc and part of the conveyor screw representing one embodiment of the present invention.

FIG. 3A is a longitudinal detail sectional view similar to that shown in FIG. 3, wherein the die former and finishing tube do not rotate.

FIG. 3B is a cross-sectional view taken at an input end of a die former looking downstream towards the output end, showing a non-circular output end on the die former.

FIG. 4 is a cross-sectional view looking in the direction of the arrows 4—4 in FIG. 3.

FIG. 5 is a cross-sectional view looking in the direction of the arrows 5—5 in FIG. 3.

FIG. 5A is a cross-sectional view at line 5A—5A in FIG. 3 showing a circular finishing tube.

FIG. 5B is a cross-sectional view taken at line 5B—5B in FIG. 3A showing a non-circular finishing tube.

FIG. 6 is a sectional view showing a typical hollow core slab of concrete as formed on the concrete extrusion machine of the present invention.

FIG. 6A is a plan view of a concrete extrusion machine according to one embodiment of the present invention for extruding the concrete slab shown in FIG. 6.

FIG. 7 is a sectional view taken at 7—7 of FIG. 1 showing side plate vibrators according to an embodiment of the invention.

FIG. 8 is a sectional view taken at line 8—8 of FIG. 7

FIG. 9 is a top plan view of a top plate with a motor mounted on a frame and an eccentric drive to reciprocate the top plate.

FIG. 10 is a sectional view taken at line 10—10 of FIG. 9.

BEST MODES FOR CARRYING OUT THE INVENTION

FIG. 1 illustrates an extrusion machine **11** showing a hollow concrete slab **12** extruded from the machine onto a base and track **14**. There is a hopper **16** through which the concrete is fed to the machine **11** and an electric motor **18** to drive the extruder screws. The machine **11** has wheels **24** to move the machine **11** on the track **14** in the direction of the arrow as the slab **12** is extruded. This is an existing type of machine known in the prior art.

FIG. 2 illustrates the machine of FIG. 1 in somewhat more detail. The hopper **16** leads to an extruder screw **26** which has a trough **28** to guide the concrete as it is extruded. The extruder screw **26** compacts the concrete as it moves towards the outlet end **27**. A die former **30** is connected to the outlet end **27** of the extruder screw **26**, which in turn is connected to a finishing tube **32**. The extruder screw **28** is driven by the motor **18** as shown in FIG. 1 through the chain drives **29** which rotate a chain sprocket **34**. A stationary tubular shaft **36** extends through the extruder screw **26**, on the extruder screw axis, and is connected to the die former **30** so that the die former **30** itself does not rotate. Furthermore, the finishing tube **32** is attached to the die former **30** therefore it too does not rotate. An eccentric weight **38** inside the die former **30** is mounted in bearings **40** and driven by shaft **42** from a high speed motor **43** rotating at a speed of approximately 12,000 rpm. The eccentric weight **38** causes the die former **30** to vibrate. The die former **30** itself is not flexibly mounted thus a high speed is required to provide a high frequency vibration to the die former **30**.

The die former **30** has a slightly larger exterior cross-section than that of the finishing tube **32** to allow for some contraction as the machine advances and the concrete hardens. The speed of the machine **10** is variable but is dependent on the cross section of the slab **12** and the materials in the concrete mix. When several extruder screws are positioned side-by-side, it is necessary to control the feed of concrete through the hopper **16** to each screw. In some situations more concrete is needed in the end extruder screws to ensure the slab has a consistent thickness across the width.

Above the die former **30**, and attached on each side of the machine **11** is a top plate **44** which has mounted thereon a vibrator motor **46**. The vibrator motor rotates at 12,000 rpm and has a small eccentric weight therein to provide a similar vibration to the top plate **44** as is provided by the eccentric weight **38** rotating in the die former **30**. The top plate **44** is vibrated to assist in compacting the concrete and to remove air from within the wet concrete. A troweling or finishing plate **48** is positioned downstream of the top plate **44**. This finishing plate **48** smooths out the top of the concrete slab **12** as the machine moves along the track **14** leaving a smooth surface. An improved system for reciprocating the top plate **44** and a system for reciprocating side plates will be shown hereafter.

The extruding machine described and shown in FIGS. 1 and 2 is the type known in the prior art. In both cases the vibrating mechanisms are powered by motors that have to rotate at about 12,000 rpm and these motors operate on a high frequency produced by a frequency converter **49** positioned on one end of the machine **11** as shown in FIG. 1. All frequency converters are excessively noisy which, added to the vibratory noise from the forming dies **30** and vibrating plate **44**, provides an unpleasant work environment.

FIGS. 3 to 5 illustrate an embodiment of the present invention with a different system for vibrating or eccentrically moving the die former **30**. In this embodiment there is provided a compaction disc **50** mounted on the outlet end **27** of the extruder screw **26** and having a concentric disc face **52** adjacent the outlet end **27** of the extruder screw **26** concentric with the extruder screw axis **53**. The diameter of this concentric disc face **52** is somewhat smaller than the diameter of the outlet end **27** of the extruder screw **26** to ensure there are no restrictions to prevent the flow of concrete off the extruder screw **26**. The compaction disc **50** has an eccentric disc face **54** which is not parallel to the concentric disc face **52** but is coplanar with an input end **55** of the die former **56**. The die former **56** at the input end **55** is mounted on a bearing **58** which in turn rotates on a bushing **60** which is eccentric to the conveyor screw axis **53**. This eccentricity represents the same eccentricity as the compaction disc **50** between the concentric disc face **52** and the eccentric disc face **54**, and therefore the eccentric disc face **54** is coplanar and has exactly the same diameter as the input end **55** of the die former **56**.

The compaction disc **50** is keyed to a portion of the eccentric bushing **60** concentric with the conveyor screw axis **53** and is attached to a tubular drive shaft **62** that rotates at approximately 500 rpm. Thus, the drive shaft **62** is rotated through gears or chain and sprocket by a motor driven off standard frequencies and no frequency converter is required. When the shaft **62** rotates, the compaction disc **50** rotates with it and the eccentric bushing **60** also rotates which causes the input end **55** of the die former **56** to move in a circular orbital path about the extruder screw axis **53**. The output end **63** of the die former **56** has another bearing **64** mounted on the end of the tubular drive shaft **62** concentric with the conveyor screw axis **53**. Thus the die former **56** may remain stationary as the tubular drive shaft **62** rotates. A Teflon, registered trade mark for Polytetrafluroethylene, seal **66** is provided in the input end **55** of the die former **56** which rotates up against the eccentric disc face **54** of the compaction disc **50**. A further Teflon seal **67** is provided in the output end **27** of the conveyor screw **26** which rotates up against the concentric disc face **52** of the compaction disc **50**. These seals prevent liquid or concrete paste from entering the die former **56** or cavities in the conveyor screw **26**.

FIG. 4 illustrates a section looking in the direction of arrows 4—4 in FIG. 3 on the eccentric disc face **54** showing that the eccentric disc face **54** is not concentric with the conveyor screw axis **53**. FIG. **5** illustrates the same section looking in the direction of arrows **5**—**5** on the input end **55** of the die former **56**, showing how the seal **66** and the periphery of the die former **56** are eccentric relative to the conveyor screw axis **53** yet concentric with the eccentric disc face **54** of the compaction disc **50**.

A flexible seal **70** is provided between the output end **63** of the die former **56** and the attachment end **71** of the finishing tube **32**. The flexible seal **70** permits the input end **55** of the die former **56** to move in the circular orbital path. The seal **70** compresses and flexes as the orbital movement moves the output end **63** of the die former **56** relative to the attachment end **71** of the finishing tube **32**. As shown the finishing tube **32** is attached to a central shaft **72** by a thrust bearing **74**, thus the finishing tube **32** is held in position but is free to rotate. The finishing tube **32** is joined at the attachment end **71** to the flexible seal **70** by bolts **76**. Long bolts **77** join the flexible seal **70** to the output end **63** of the die former **56**, thus the finishing tube **32** and the die former **56** cannot rotate relative to each other, but can rotate together.

The embodiment shown illustrates a die former **56** and finishing tube **32** which have a circular cross-section, as shown in FIGS. **5** and **5A**, and on this basis the die former **56** and finishing tube **32** are free to rotate but are not driven. If, however, the cavity or hollow in the concrete slab is not circular but is oval, or another non-circular shape, then the thrust bearing **74** is omitted and the finishing tube **32** is keyed to the fixed shaft **72**, as shown in FIGS. 3A, 3B and 5B, so that neither the finishing tube **32** nor the die former **56** can rotate. The die former **56** to produce a non-circular cavity starts with a circular input end **55** and slowly changes shape along the length to the required shape at the output end **63**. This is seen in FIG. 3B which is a cross-sectional view looking downstream from the input end **55** of the die former **56** similar to FIG. **5** which shows a die former **56** to produce a circular cavity. The cross-sectional shape of the finishing tube **32**, as shown in FIGS. 5A and 5B, is preferably slightly smaller than that of the output end **63** of the die former **56** to allow for relaxation of the concrete as it hardens.

As well as compacting the concrete with the eccentric rotation of the die former **56**, in another embodiment, compacting side plates **90** are provided as shown in FIGS. **7** and **8**. Side members **92** of the extrusion machine **11** support the compacting side plates **90** with flexible mountings **94**, and rubber seals **96**, at the bottom of the side plates **90** rest on the tracks **14** to prevent concrete paste leaking as the extrusion machine **11** advances.

As shown in FIG. **8**, a drive shaft **98** is supported by two pillow block bearings **100** mounted on the side member **92**, and is driven by a chain and sprocket **102**. A motor which, is preferably a 3600 rpm motor (not shown), so that it can operate on a standard frequency rotates the shaft, and the drive shaft **98** has an eccentric end **104** which rotates in another pillow block bearing **106** mounted on the inside of the compacting side plate **90**. Thus an eccentric movement from the eccentric shaft end **104** is transferred to the compacting side plates **90** which has a compacting effect upon the sides of the concrete slab **12** as the machine **11** advances.

FIGS. **9** and **10** illustrate a compacting top plate **110** replacing the vibratory top plate **44** shown in FIG. 2. A cross support member **112** extends across the two side members **92** and has a bracket **114** attached thereto having a motor **116** which drives belt drive **118** to a drive shaft **120**. This is supported on pillow block bearings **122** from the cross support member **112**. The drive shaft **120** has eccentric end bushings **124** which rotate in bearings **126** attached to a reciprocating arm **128** attached to the compacting top plate **110** by rubber bushings and washers **130**. The motor **116** rotates at 3600 rpm in one embodiment and provides a reciprocal movement through the eccentric bushing **124** and the rubber bushings **130** to the compacting top plate **110**. The compacting effect is adequate for compacting the concrete and releasing air. A finishing plate **48** is shown supported from the cross support member **112** and performs the same function as shown in FIG. 2.

FIG. **6** illustrates a concrete extruded slab **12** resting on a base **14** having cavities **80** therein. After the machine **10** as shown in FIG. **1** and FIG. **6A** has extruded the slab **12**, and the concrete has hardened, it is cut by a diamond saw into the required lengths.

The extruder screw **26** generally rotates at about 50 rpm, whereas the compaction disc **50** is required to rotate at about 500 rpm. It has been found that a vibratory motor **46** mounted on a top plate **44** as shown in FIG. 2 may rotate at approximately 3600 rpm. An eccentric weight rotating at this speed provides sufficient vibration to assist in compacting the concrete and releasing air as the concrete slab is formed. The top plate **44** is supported on mounts (not shown) that are sufficiently flexible so the rotor **46** vibrates the plate **44**.

Various changes may be made to the embodiments shown herein without departing from the scope of the present invention which is limited only by the following claims.

The embodiments of the present invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an extruder apparatus for making an elongated article of concrete, including at least one extruder screw and feed means to feed concrete to the extruder screw to form the elongated article and move the apparatus along a trace, the extruder screw having a die former at an outlet end to form a cavity in the elongated article, and a finishing tube at an output end of the die former to provide smooth walls in the cavity, the improvement of means for compacting the elongated article while being formed, comprising:

an eccentric compaction disc between the outlet end of the extruder screw and an input end of the die former, the disc having a concentric disc face adjacent the outlet end of the extruder screw concentric with an extruder screw axis, and an eccentric disc face eccentric with the extruder screw axis;

the input end of the die former being eccentric and coplanar with the eccentric disc face, mounted for movement in a circular orbital path about the extruder screw axis;

the output end of the die former being concentric with the extruder screw axis, and

means to concurrently rotate the disc and cause the input end of the die former to move in the circular orbital path.

2. The extruder apparatus according to claim **1** wherein a plurality of extruder screws are provided to form a plurality of cavities in line in the elongated article.

3. The extruder apparatus as claimed in claim **1** wherein the output end of the die former and the finishing tube are circular, and wherein the die former and the finishing tube are together free to rotate.

4. The extruder apparatus according to claim **1** wherein the output end of the die former is not circular, and the die former and the finishing tube are not free to rotate.

5. The extruder apparatus according to claim **4** wherein the finishing tube is attached to a fixed shaft extending from within the extruder screw on the extruder screw axis.

6. The extruder apparatus according to claim **4** wherein the die former has a circular input end, a cross-section that changes gradually from the input end to the output end and wherein the finishing tube has the same cross-sectional shape as the output end of the die former.

7. The extruder apparatus according to claim **1** including a flexible seal between the die former and the finishing tube.

8. The extruder apparatus according to claim **1** wherein the means to rotate the disc and cause the input end of the die former to move in the circular orbital path, comprises a tubular shaft keyed to the disc.

9. The extruder apparatus according to claim **8** wherein the finishing tube is supported on a fixed shaft extending from within the extruder screw, and wherein the die former is supported on bearings mounted on an eccentric bushing attached to the tubular shaft.

10. The extruder apparatus according to claim **1** wherein the finishing tube has means to prevent rotation relative to the die former.

11. The extrusion apparatus according to claim **1** wherein the die former output end has a larger cross-section than the finishing tube.

12. The extruder apparatus according to claim **1** wherein the finishing tube has a consistent cross-section throughout its length.

13. The extruder apparatus according to claim **1** including a seal between the eccentric disc face of the disc and the input end of the die former.

14. The extruder apparatus according to claim **1** wherein the means to concurrently rotate the disc and cause the input end of the die former to move in the circular orbital path, rotates at approximately 500 rpm.

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